May 21, 1968 W. SHRINER 3,384,089

SURGICAL WOUND DRAIN HAVING AN INNER COLLAPSIBLE TUBE PREVENTING REVERSE FLOW INTO THE WOUND

Filed March 11, 1966 2 Sheets-Sheet 1

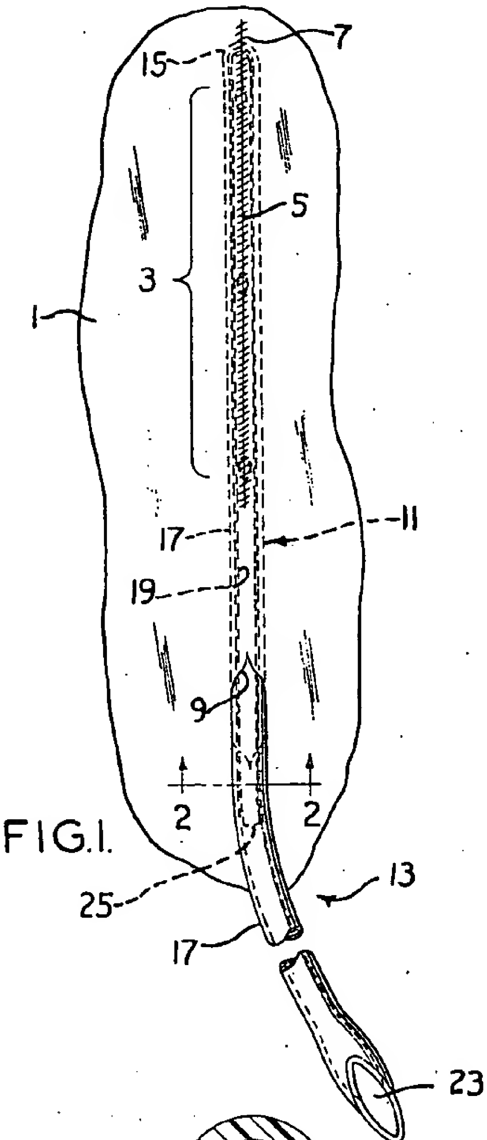

FIG.1.

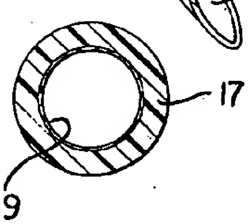

FIG.2.

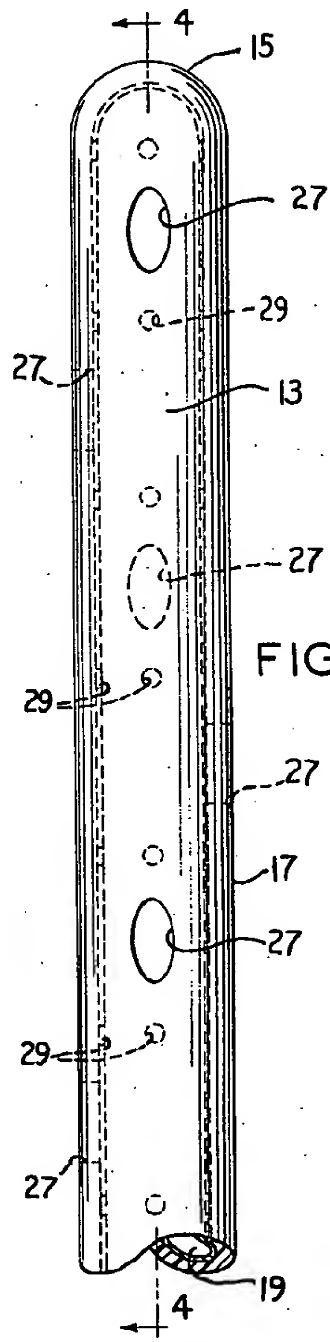

FIG.3.

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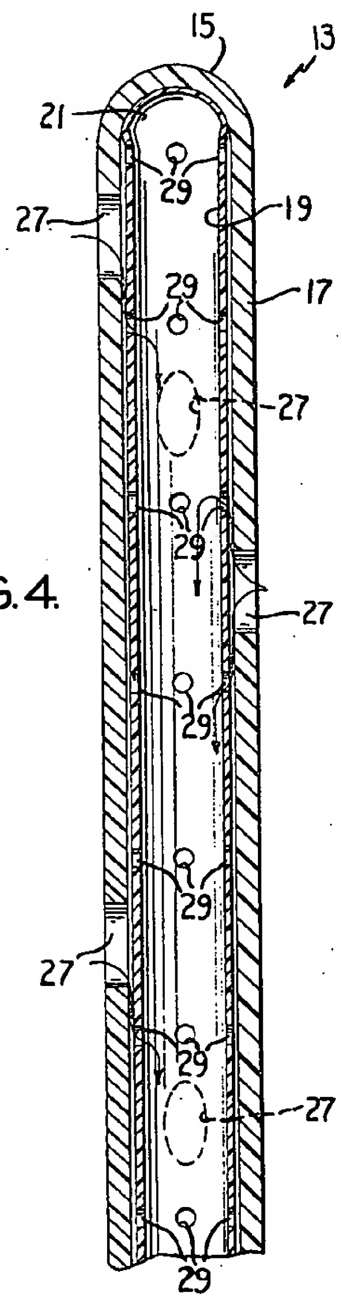

FIG. 4.

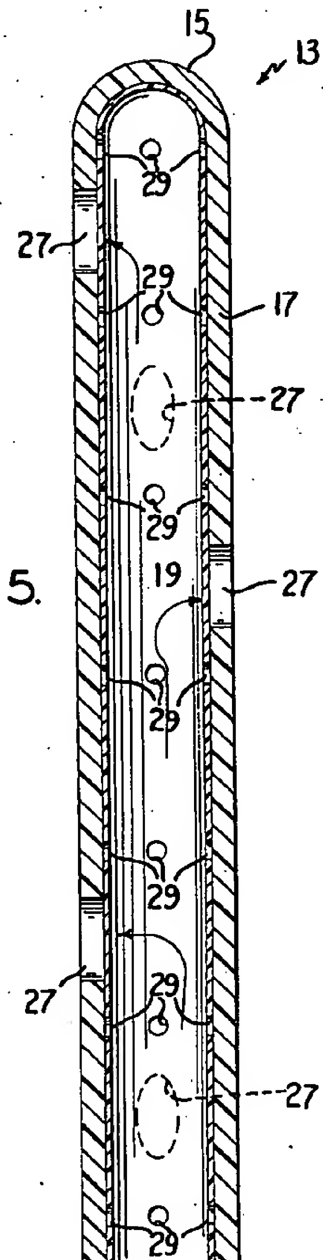

FIG. 5.

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SURGICAL WOUND DRAIN HAVING AN INNER COLLAPSIBLE TUBE PREVENTING REVERSE FLOW INTO THE WOUND

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This invention relates to surgical drains for use in the medical arts.

Among the several objects of the invention may be noted the provision of a conveniently operable surgical drain for draining seromatous fluids or the like from live body cavities, including post-operative cavities, either deep or shallow; the provision of a surgical drain which provides for one-way drainage distally from a cavity and prevents back-flow to the cavity of possibly infectious materials; the provision of a drain which is comfortable and provides for free mobility of the user; the provision of a drain having an outward pumping action induced by normal anatomical movements such as occur in normal respiratory or muscular movements; and the provision of a drain of this class which is sterilizable, easily disposable and of low cost. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the appended claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

FIG. 1 is a diagram illustrating the drain and one example of its use;

FIG. 2 is an enlarged cross section taken on line 2—2 of FIG. 1;

FIG. 3 is an enlarged fragmentary side view showing one end of the drain;

FIG. 4 is a longitudinal section taken on line 4—4 of FIG. 3, illustrating the drain in an outwardly draining state; and

FIG. 5 is a view similar to FIG. 4, illustrating the drain in a state wherein inward flow is checked.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Briefly, the invention comprises two coaxially assembled flexible tubes, an inner one of which is substantially radially collapsible and has an outside diameter providing for normal substantially close interfacial fluid-sealing fit within the outer tube. The outer tube is exteriorly smooth and is substantially noncollapsible in a radial direction. Each tube has a closed end adjacent that of the other. The inner tube is preferably shorter than the outer tube. Both have orifices adjacent their closed ends but their respective orifices are out of register. Preferably each, but at least the outer tube, has an unperforated portion for distal drainage of material received from the inner tube. Both tubes are axially bendable. The radially collapsible inner tube acts as a pumping element. The outer tube, although bendable for responding to body movements when emplaced, has a degree of stiffness sufficient for pushing it axially for insertion into a body without buckling or kinking. Relative smaller and larger collapsibilities of the outer and inner tubes, respectively, may be obtained by suitable choices of their materials and/or wall thicknesses.

Referring now more particularly to FIG. 1, numeral 1 indicates the surfaces of a live body which includes within it a region 3 required to be drained, as for example, under a main operative incision 5, illustrated as being stitched at 7. At 9 is shown a small incision separate from

the main operative incision 5, connected thereto by a prepared subcutaneous tunnel 11. The drain as a whole is numbered 13 and in this example has its closed end 15 pushed into the region 3, to be drained by insertion through the separate incision 9 and subcutaneous tunnel 11. It will be understood that the separate incision 9 and tunnel 11 are not always necessary and that the drain may extend from region 3 through the main incision 5 or through other appropriate passages, as will be understood by medical practitioners. In view of the following, it will also be understood that the position of the part of the drain in region 3 is not necessarily straight and that it may bend in that region without kinking or buckling in response to pressures of surrounding body structures.

The drain 13 as a whole is constituted by an outer tube 17 and an inner tube 19, each of which has a sufficient flexibility for bending as suggested in FIG. 1, the outer tube 17 having a moderate degree of rigidity so as to be substantially noncollapsible in a radial connection, whereas the inner tube 19 is to some degree collapsible and expandible in such a direction. The moderate degree of rigidity of the outer tube 17 does not preclude its being bent along its axis, but this occurs without kinking or buckling such as might cause the inside of the drain to be pressed shut by pressure of surrounding body structure. The inner tube 19 has a closed end 21 abutting or close to the closed end 15 of the outer tube 17. The closed end 15 of the outer tube is rounded to facilitate piloting it through suitable passages to the area to be drained such as 3. Both tubes 17 and 19 are composed of materials which are inert to chemical attack by body fluids to be drained. For example, the tube may be composed of suitable extruded materials such as vinyl or polystyrene resins or the like. As extruded they have smooth surfaces.

The distal end of the outer tube 17 is provided with a chamfered outlet 23 (FIG. 1). The distal open end 25 of the inner tube 19 preferably does not extend to the outlet 23. In case both tubes 17 and 19 are composed of the same material, the thickness of the outer tube 17 is made greater than the thickness of the inner tube 19 as illustrated, for example, in FIG. 2. Their geometry under equalized inner and outer pressures is such that there is a snug sealing fit and interfacial contact is established between the outside diameter of the inner tube 19 and the inside diameter of the outer tube 17 (FIGS. 2, 3 and 5). The thickness of the outer tube 17 is made such that while it is moderately stiff but axially bendable, it is radially substantially noncollapsible. The wall of the inner tube 19 is thin enough that it is somewhat collapsible in response to pressure applied externally thereto so that said interfacial contact may be disestablished in whole or in part. For example but without limitation, in the case of the use of vinyl resin tube 17 may be ¼ inch O.D. and have a 1/32 inch wall thickness and tube 19 may have a normal O.D. of ⅛ inch with a wall thickness of 1/64 inch leaving a 3/32 inch I.D. of tube 19.

The outer tube 17 is provided with a spirally disposed array of inlet openings or orifices 27, these being shown as of elliptical or ovate form with their long axes parallel with the axis of the tube 17. Such shapes minimize scarification of tissue when the tube 17 is inserted into the body.

The inner tube is provided with an array of smaller orifices or openings 29 which are out of registry with the orifices 27. Each of these orifices may be circular and preferably smaller than the inside diameter of tube 19 and smaller than an orifice 27.

Normally, when the tubes 17 and 19 are under balanced external and internal pressure, there occurs an interfacial sealing contact between them as illustrated in FIGS. 2, 3 and 5. The same will be true if the interna

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pressure within the inner tube 19 exceeds the external pressure applied to the outside of tube 17. Under such conditions, the orifices 27 and 29 are sealed off from one another. Under conditions of outside pressure applied through orifices 27 to the inside tube 19 greater than the inside pressure within tube 19, the inner tube 19 will be pressed in, as shown diagramatically in FIG. 4, thus placing the orifices 27 in communication with the orifices 29 through the space or spaces provided between the tubes 17 and 19 when the latter collapses radially in response to such pressure. It will be understood that separation may occur all along the perforated parts of the tubes, or at intervals, and that the separation will be sufficient even if only of capillary dimension.

Operation is as follows: The drain 13 is pushed through a suitable passage in the body as, for example, the incision 9 and tunnel 11, so that its end 15 and the range of orifices 27 and 29 are proximal to the region of drainage 3 (see FIG. 1). As serous or other fluids generated in the region 3 accumulate, superatmospheric pressure will build up to some degree on the outside of the outer tube 17. This pressure enters the orifices 27 to press the collapsible inner tube 19 inwardly at one or more points. As illustrated in FIG. 4, this establishes communications between some or all of the outer orifices 27 and some or all of the inner orifices 29, such communications being provided by the then-existing capillary or larger space or spaces between the substantiallly noncollapsible outer tube 17 and the somewhat collapsed inner tube 19. Bodily movements of a patient may also tend to increase pressure on accumulating fluids, with the same effect. Material that enters the inner tube 19 passes from its lower end 25 into the outer tube 17 from which it drains from its distal outlet 23. Thus excursive bodily movements also bring about a pumping action to effect efficient drainage. The several darts on FIG. 4 illustrate a few typical drainage paths of which there are others not provided with darts.

Bodily movements such as above mentioned will from time to time result in subatmospheric pressure on the outside of the outer tube 17 in the region 3. Then outer atmospheric pressure enters the inner tube 19 through the outer tube 17. As a result, tube 19 will expand into sealing engagement with the outer tube 17. Such engagement seals off the inner orifices 29 so that inward flow is prevented to the region 3 of any substances which might be infectious. Thus it will be seen that pressures generated by fluid increase and/or normal excursions or movements (respiratory or others) are sufficient to push or pump out accumulated fluids from the region 3 and to prevent back-flow of fluid thereto. A very small back pressure is sufficient to prevent back-flow, as for example a few centimeters of water head pressure. Several darts on FIG. 5 illustrate how reversely acting back pressure exerts closure of orifices.

In the form of the invention illustrated in the drawings, the differential collapsibility of the tubes 17 and 19 is brought about by the difference in their thicknesses, as, for example, when each is made of the same inert material. Differential collapsibility can also be obtained by tubes having more nearly the same wall thickness provided that the material selected for the inner tube has a compressibility which is greater than that of the outer tube so as to open and close orifice-connecting space between the tubes as pumping action takes place.

Orifices 27 and 29 in the outer and inner tubes 17 and 19, respectively, may be of the same size. However, it is preferred that each orifice 29 in the inner tube 19 shall be smaller in area than an orifice 27 in the outer tube 17, and also that the number of orifices 27 and 29 shall be such that the total area of orifices 29 shall be less than the total area of orifices 27. Thus in the drawings there are sixteen small orifices 29 for each four large orifices 27 and the area of each large orifice 27 exceeds that of four small orifices 29. However, these figures are not to be taken as limiting. Such an arrangement assures the most free outward flow under a given pressure drop between region 3 to the atmosphere and the most reliable checking action against back-flow under a given pressure drop from the atmosphere to said region 3.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A surgical drain comprising an outer axially bendable tube which is substantially noncollapsible, an inner collapsible tube coaxially disposed in the outer tube and bendable therewith, said inner tube having an outer diameter when uncollapsed to establish a sealing interfacial contact with the outer tube, said tubes being formed with adjacent closed ends and having nonregistered orifices therein, the opposite ends to said tubes being open.

2. A drain according to claim 1 wherein the total area of the orifices in the outer tube exceeds the total area of the orifices in the inner tube.

3. A drain according to claim 2 wherein the area of each orifice in the outer tube exceeds the area of each orifice in the inner tube.

4. A drain according to claim 3 wherein the orifices in the outer tube are of ovate form with the long axes of the forms extending in the general direction of the axis of the outer tube.

5. A drain according to claim 1 wherein the open end of the inner tube is spaced a substantial distance inward from the open end of the outer tube.

6. A drain according to claim 1 wherein both tubes are composed of a resinous material which is inert to live body fluids and the wall thickness of the outer tube substantially exceeds that of the inner tube.

7. A drain according to claim 6 wherein said inert material is a smoothly extruded vinyl resin.

8. A drain according to claim 6 wherein said inert material is a smoothly extruded polystyrene resin.

9. A surgical drain comprising a bendable substantially noncollapsible outer tube, a radially substantially collapsible inner tube having an uncollapsed diameter to establish an interfacial fluid-sealing fit with the inner wall of the outer tube, said tubes being closed at adjacent ends and each being open at its other end, each tube having orifices through its wall arranged along the sealing fit and out of register with the orifice of the other, said inner tube being collapsible in response to unbalanced external pressure applied thereto through the openings in the outer tube to disestablish said sealing fit whereby fluid may be conveyed between the tubes from the outer openings to openings in the inner tube, said inner tube being radially substantially expansible to reestablish said interfacial sealing fit in the absence of said unbalanced external pressure to prevent reverse flow from within the inner tube to the orifices in the outer tube.

10. A surgical drain comprising:

an inner tube and a concentric outer tube, each tube being closed at one end and open at the other end, the inner tube being collapsible and having its closed end concentrically positioned within the closed end of the outer tube,

the outer diameter of the inner tube being substantially the same size as the inner diameter of the outer tube, the outer tube having at least one drain hole through it from its outer surface to its inner surface, the inner tube having at least one drain hole through it from its outer surface to its inner surface adjacent to but spaced from the drain hole in the outer tube,

whereby fluid may be drained from a body by inserting

the closed ends of the tubes into a live body, fluid in response to superatmospheric pressure on the outside of the outer tube passing first through the hole in the outer tube, then between the tubes, through the hole in the inner tube, and then through the inner tube and out its open end and whereby the inner tube seals the hole in the outer tube when said pressure becomes atmospheric or less.

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